



Joshua Lederberg

Tiny Muscles Seem to Have A Role in Brain Activity

TO MOST lay readers, brain waves must be a subject of awe and fascination that far outreach the scientific facts. It has been known for years that evidence of electrical signals in the brain can be obtained from electrodes placed upon the scalp, leaving it unnecessary to penetrate the skin. The reader will have heard that these EEG, or electroencephalographic, signals are useful in the diagnosis of epilepsy and of some other diseases of the brain.

He will have read provocative suggestions that criminally aggressive behavior might be associated with abnormal EEG's (but then what—do we scan the whole population? And what do we do when we find EEG deviations?) He will know that the EEG is being proposed as a more sensible criterion of the "living" state of the human body than the heart beat, which can be artificially stimulated for many hours after every other sign of life has decayed.

It would not be surprising, then, if many readers believed that the EEG could also be used to spy on the innermost thoughts of the subject, to translate what he is thinking into an electrical code or even in some subtle way to influence his behavior or his sense of free will.

THESE FANTASIES are founded on an exaggeration of an undoubted fact: the function of the brain is a composite of the electrical activity of all of its neuronal cells and connections. If we could get a complete record of the electrical waves from each of a hundred billion separate elements, and above all could have some hope of understanding such a staggering record, we might then have some access to the innermost processes of personality. The typical EEG record does not begin to reach this kind of insight, nor can we foresee any way of approaching this level except for the simplest forms of animal life with rudimentary nervous systems.

In fact, it is rather surprising that brain waves can be detected at all. What can be detected by an electrode on the scalp is the summation of outputs from millions of different cells. Each of them must have its own pattern of activity, and the overall effects should be mutually canceling over the whole population of contributing cells.

Nevertheless, it seems that under certain conditions, many cells are recruited into a given rhythm of about 11 beats per second, the so-called alpha wave. The alpha wave is most characteristic of quiet wakefulness with eyes shut, and again of certain stages of sleep. The alpha wave is blocked when the subject is alerted to external stimuli, and is replaced by a desynchronized, independent activity of different cells that defies simple analysis.

RECENT WORK suggests that the most crucial factor is the state of the muscles of the eye. When the eyeball is directed upward, the alpha wave is the most prominent; when it is focused on an object to which the subject's attention is directed, the alpha wave disappears.

Dr. Joseph Kamiya of the University of California Medical Center (San Francisco) has reported that subjects can be trained to regulate their own alpha waves regardless of their overt eye positioning. An instrument was arranged to sound a tone during alpha wave activity, and most subjects learned to maintain the tone on or off at will.

When questioned later, they described the alpha-on state as one of calm, unfocused meditation. Indeed, practiced Zen meditators were found to be unusually proficient in controlling the alpha state. According to a report in *Psychology Today*,

The subjective reports of the meditative state must be given equal weight with the effects of eye muscle tension in our efforts to evaluate these findings. If nothing else, 20 years work on the EEG points to the extraordinary importance of some of the tiniest muscles in the body for the general pattern of the electrical activity of the brain, and, if so, why not also for the characteristics of mood and arousal associated with meditation? Turning off these muscles is just the kind of not-seeing that one may associate with introspection.